DELTA Loop Status and Future Plans

AFC Semiannual Review

January 2003

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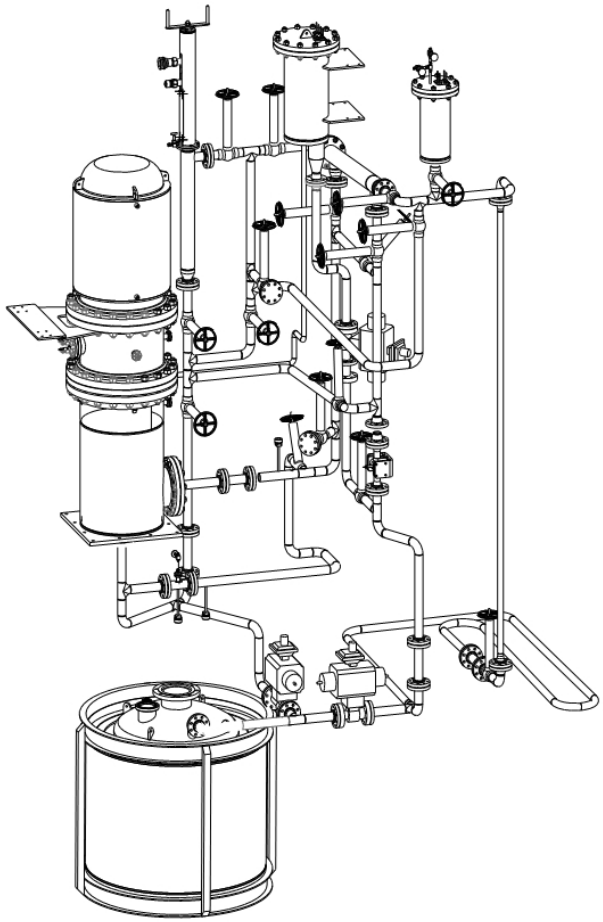
DELTA Loop at LANL TA-53

AFC
Advanced Fuel
Cycle Initiative

Los Alamos

Multipurpose Liquid Metal Testing Facility

- DELTA Loop offers tested robust and reliable operation.
- Sophisticated Data Acquisition and Control system provides management of necessary functions and collects variety of data.
- Design and procedures ensure safe operations.
- Design allows expansion to other working fluids and operating conditions.



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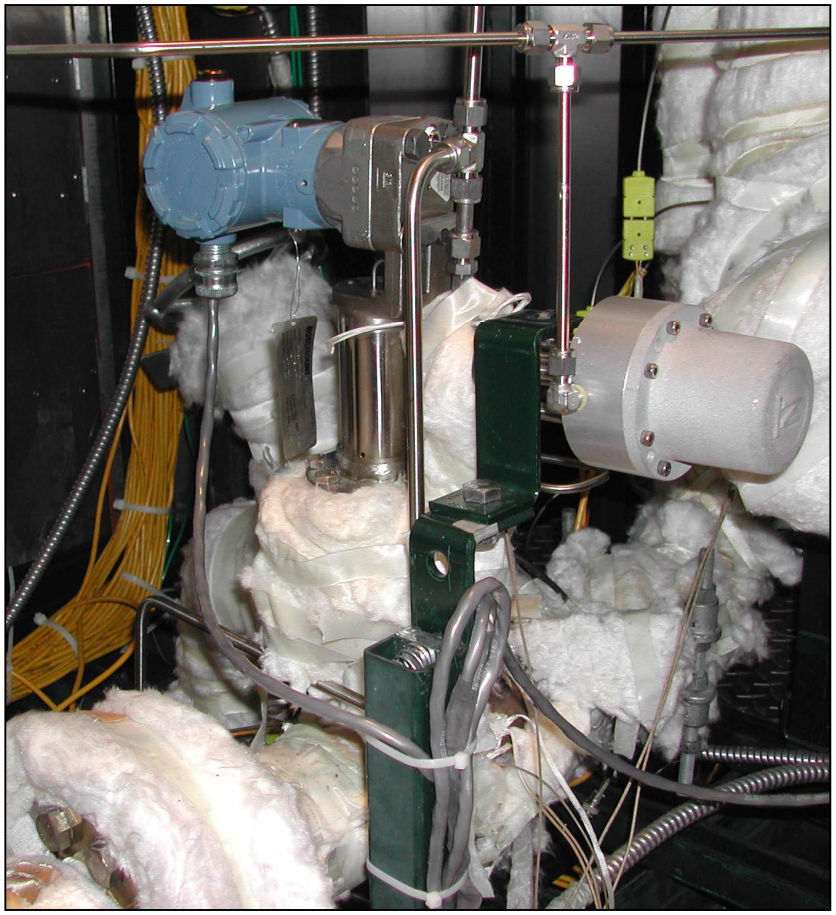
DELTA Loop Upgrades Since January 2002

- Gas system was modified, new valves and additional pressure transducers were installed to improve control and gas flow stability.
- Lead-bismuth pressure transducers were replaced several times. New gas system was designed and connected to the pressure transducers to prevent their failure in the future.



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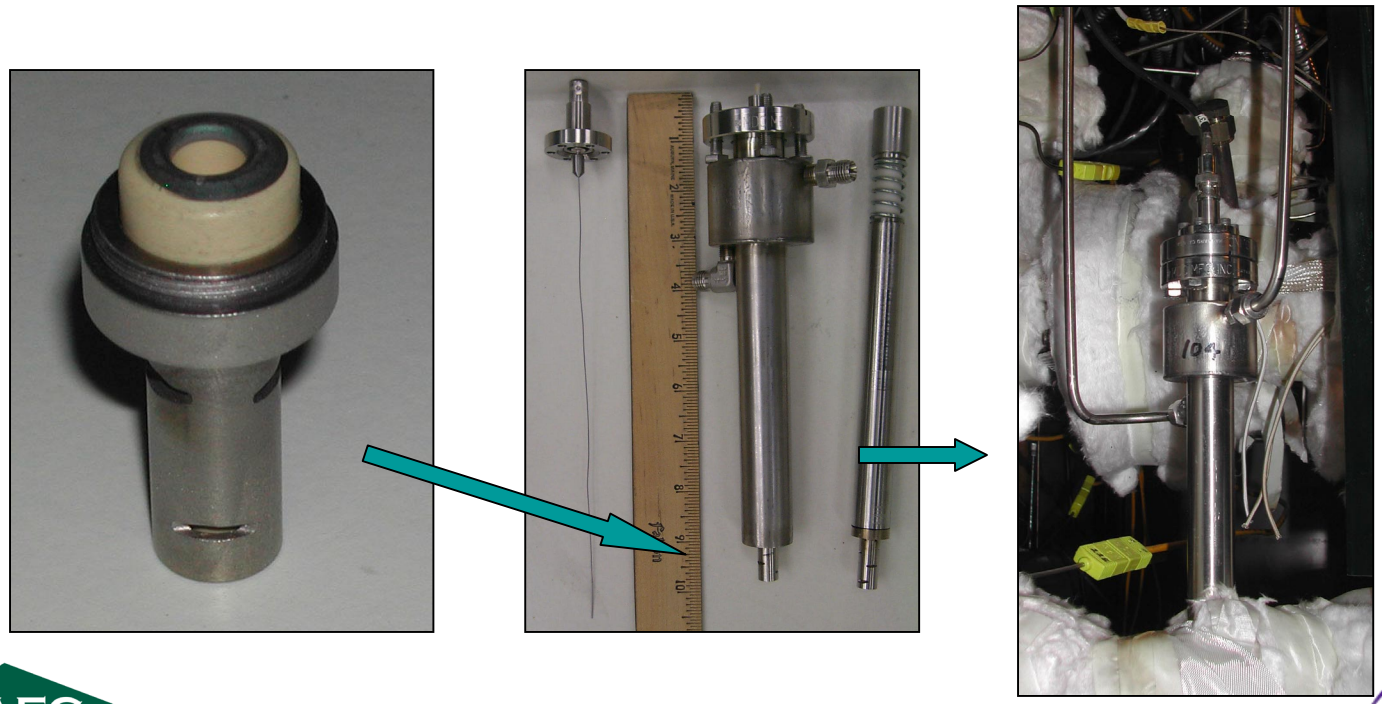
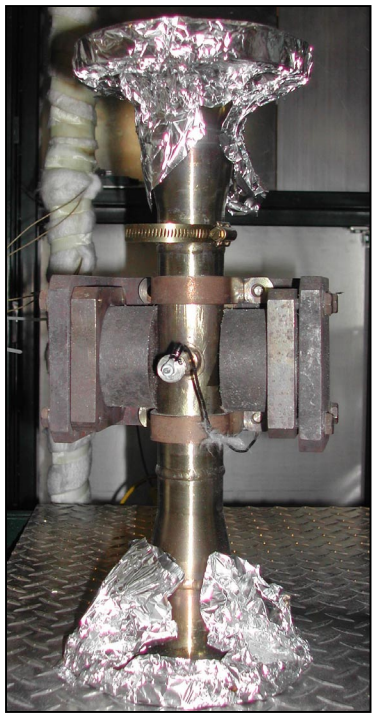
DELTA Loop Upgrades Since January 2002

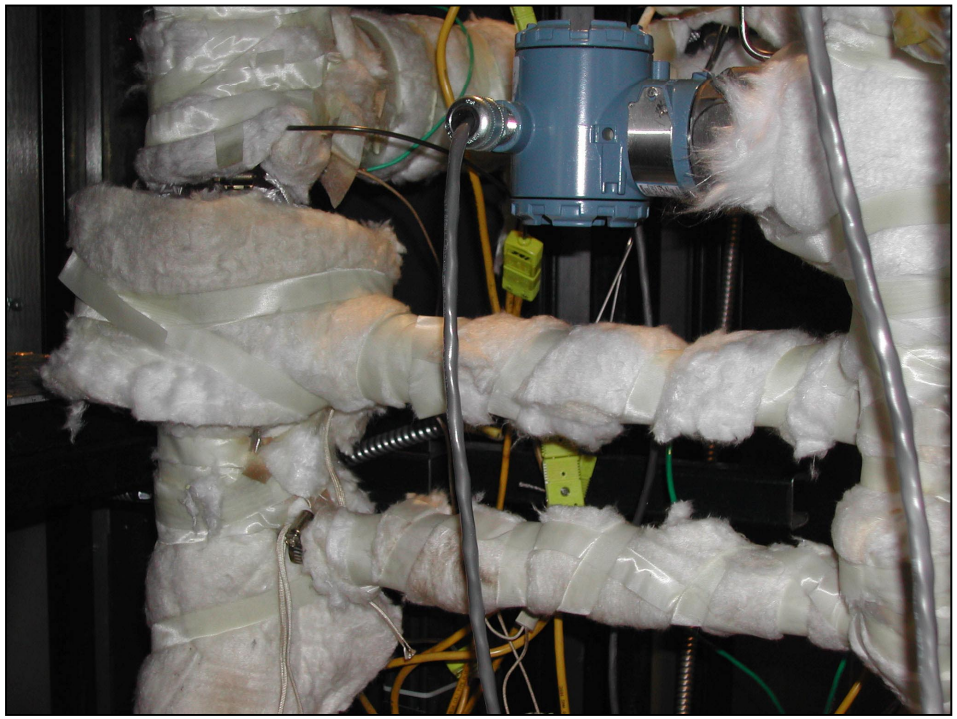
- Oxygen sensors were fitted with a protective sheath and replaced. Welded fittings were replaced. Cleaning gas injection inlet tube was replaced with better level sensors arrangement.



DELTA Loop Upgrades Since January 2002

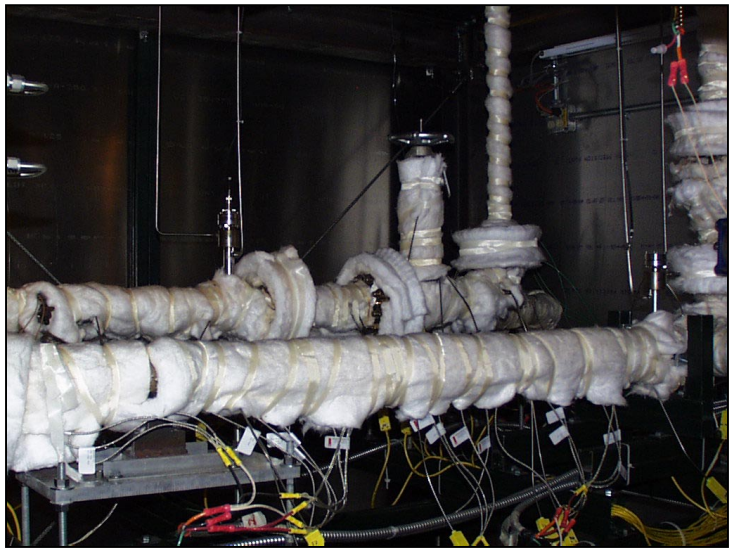
- Magnetic flow meter was replaced with a venturi flow meter for more stable measurement.

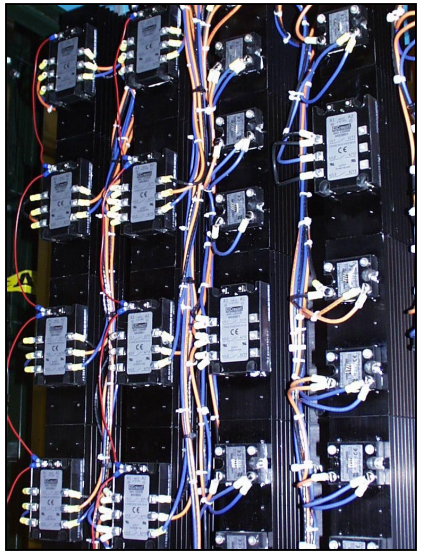




DELTA Loop Upgrades Since January 2002

- Heating zones were rearranged for more uniform temperature control and better electrical balance. Heaters' breakers and relays were upgraded.
- Heat Exchanger water and gas leaks were eliminated.





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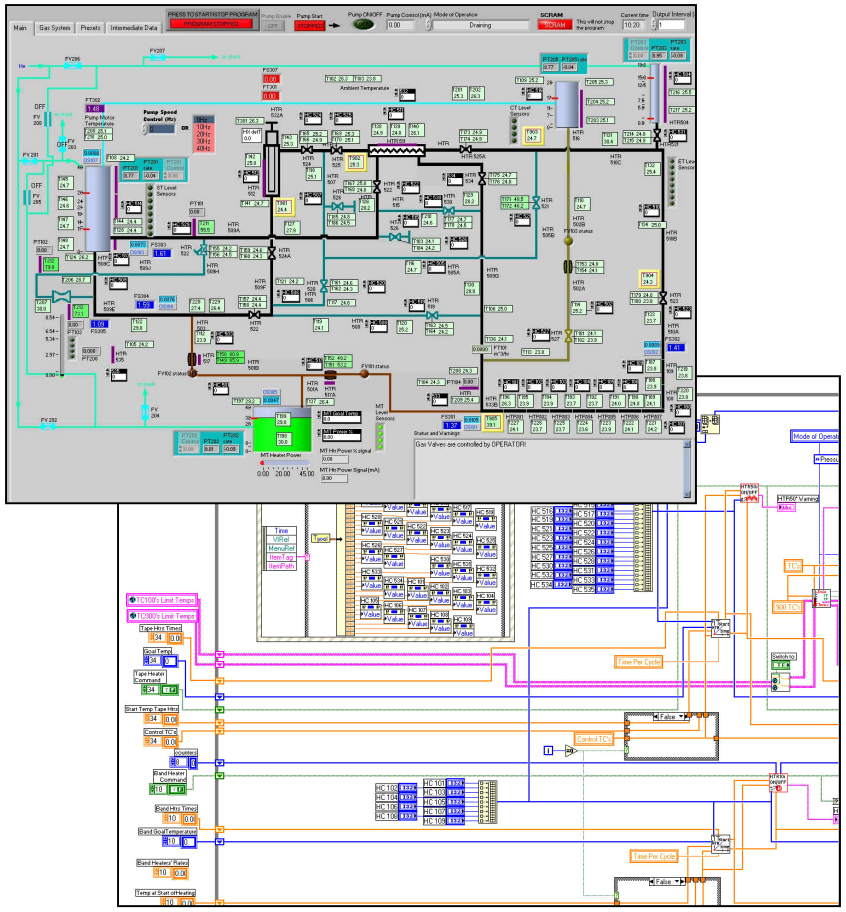
DELTA Loop Upgrades Since January 2002

- Data Acquisition Hardware was upgraded. New hardware was installed to accommodate new instrumentation and controls.
- Additional program was written to allow access to main program via internet.
- DELTA Loop Hazard Control Plan and procedures were updated based on testing experience and new controls.



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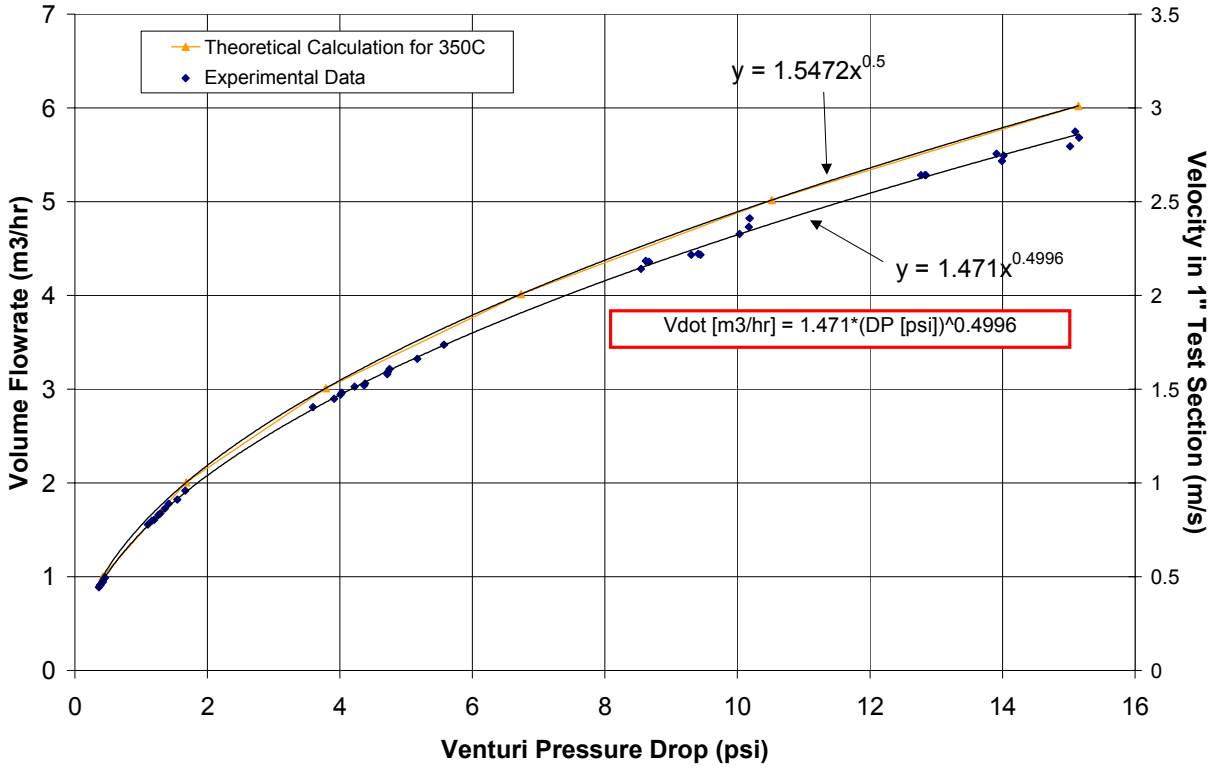
DELTA Loop Experiments and Tests Since January 2002

- DELTA loop has run 123 hours.
- Shakedown runs to test equipment and procedures.
- Continuous 48 hour run.
- Maximum Temperature: 425°C, Maximum flow speed: 7.6m^3/hr.
- Magnetic Flow Meter Calibration.
- Venturi Flow Meter Calibration.
- Cleaning gas injection system tests.
- LBE pressure transducers gas line tests.
- Numerous shut down conditions tests.

Venturi Flow Meter Calibration Successful

Venturi flow meter calibration was performed successfully.

Resulting calibration curve is consistent with predicted values.



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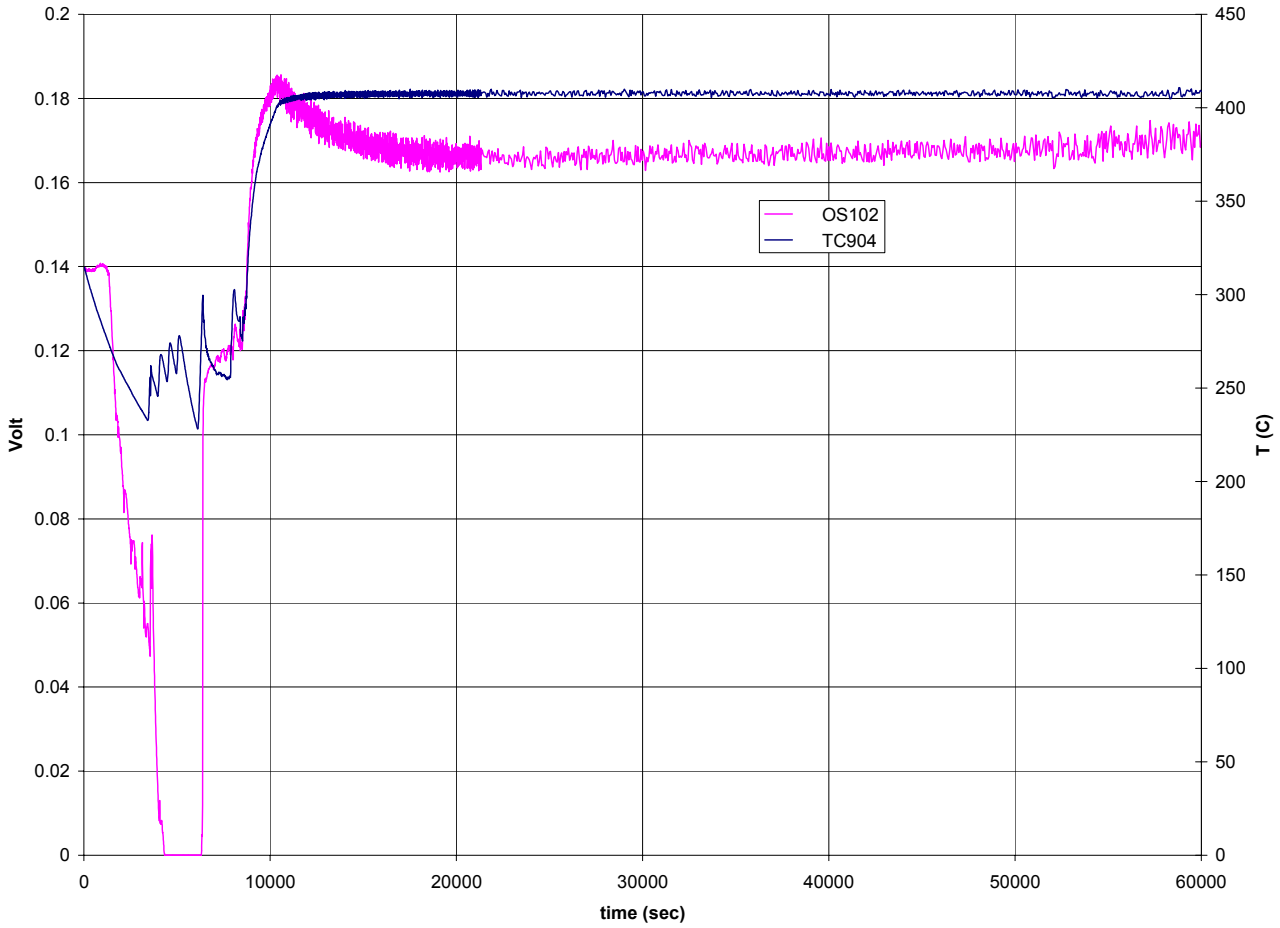
Example of DELTA data



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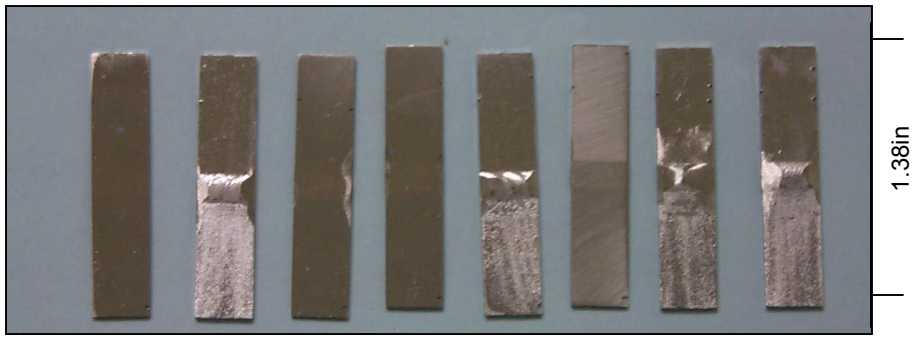
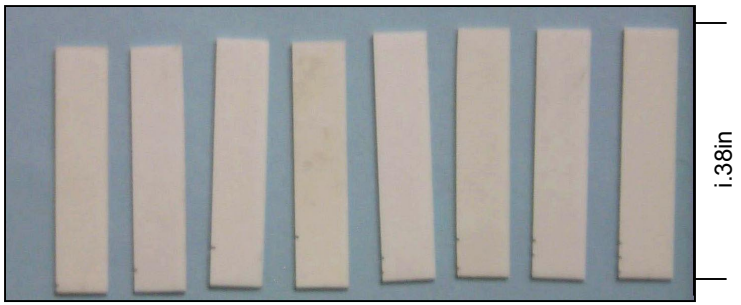
Material Samples are Ready

- Material Samples of Stainless steels 316L, HT9, T91, EP823, 316L welded to T91 and Tantalum, Iron, Iron-Silicon alloys, Alumina are ready for testing.



Welded 316L /T91 corrosion samples

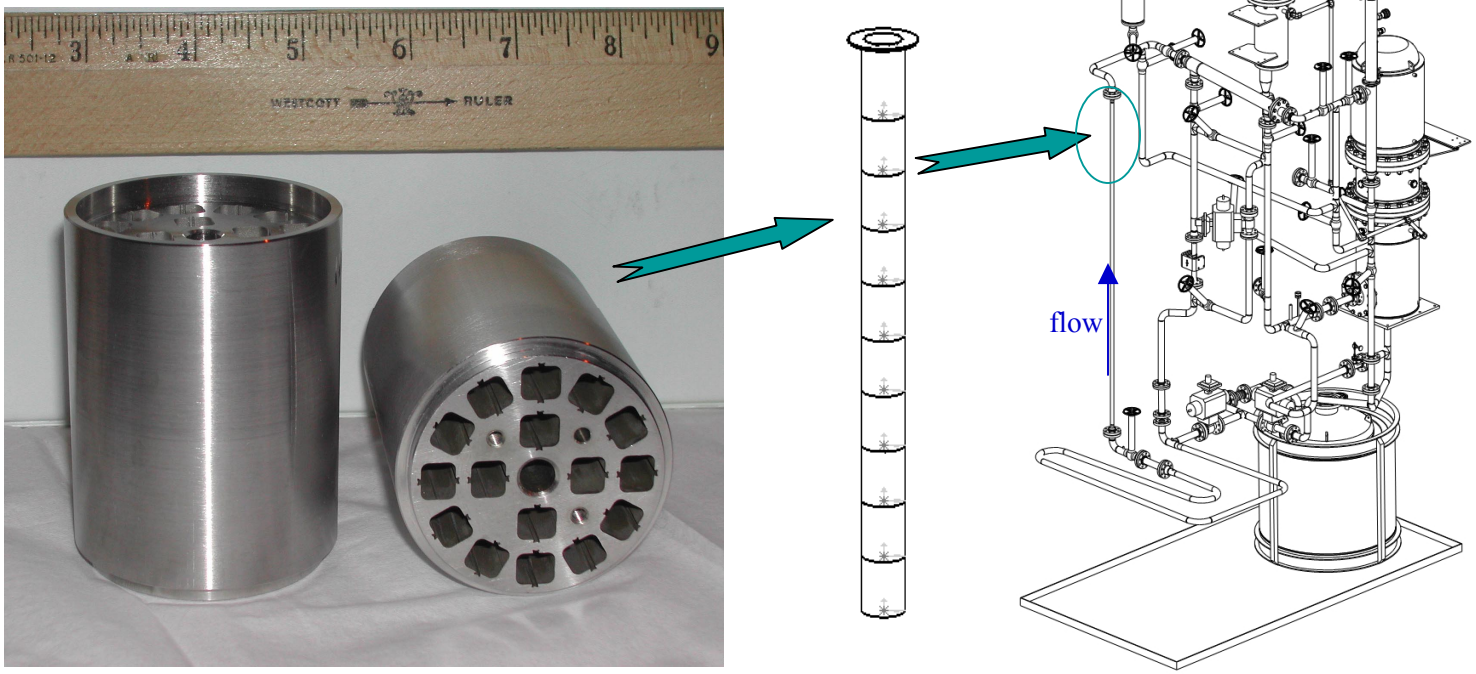


Alumina corrosion samples

HT9 tensile samples

Samples Holder is Ready

- Materials samples holder segments were machined.
- There are nine sections held together by a center rod in the holder.
- Holder hangs from the top of test section.



Objectives

- Oxygen sensor seal reinforcement.
- Material tests complete in April 2003:
  - 333 hour, 666 hour and 1000 hour durations.
  - Oxygen content controlled.
  - Temperature gradient 100°C.
  - Flow speed 2m/s at materials samples.
- Higher temperature test section design complete in April 2003. Installation in May 2003.
- 2000-3000 hour test start June 2003.

High Temperature Testing

- Reasons:
  - Interest from Generation IV nuclear reactor designs.
  - Liquid lead testing.
  - Lack of data at higher temperatures.
- New requirements:
  - Temperature up to 650°C.
  - Material different from 316 stainless steel, such as HT9.
  - Special heat exchanger can be designed using existing designs.
  - Different working fluid may need a separate drain tank.
- Similarities:
  - Lead thermodynamic properties are similar to lead-bismuth. Stress due to fluid is similar.
  - Loop piping can be designed to connect higher temperature test section with minimal additional stresses.

Lead vs. Lead-bismuth

	Lead	*Lead-Bismuth*
Density	10500 kg/m³	10300 kg/m³
Viscosity	1.8×10^{-7} m²/s	1.6×10^{-7} m²/s
Specific heat	147.4 J/kg °C	146.5 J/kg °C
T melt	327.4°C	123.5°C
Thermal Expansion	0.00011 m³/ m³ °C	0.00011 m³/ m³ °C
Latent Heat	24.1 J/g	22.5 J/g
Expansion on Melting	3.4% volumetric	1.5% volumetric

DELTA Loop Available for Higher Temperature Testing

- Additional test section and auxiliary components can be designed within a year.
- DELTA loop can be utilized for lead and lead-bismuth testing.
- DELTA loop is already equipped for complete and extensive tests:
  - Sophisticated instrumentation already exists.
  - High fluid flow capacity.
  - Variable flow paths.
  - Operating experience.